January 1997 ISSN 1195-2512 Vol. 5 No. 1

PICES Press

Newsletter of the North Pacific Marine Science Organization (Published semi-annually)

Highlights of PICES-V

The Fifth Annual Meeting of the North Pacific Marine Science Organization (PICES) took place on October 11-20 in Nanaimo, B.C., Canada. The meeting was well attended with more than 230 participants from all six member countries (Canada, China, Japan, Korea, Russia and U.S.A.), plus two invited speakers from Australia and United Kingdom and representatives from international scientific organizations SCOR, ICES, NPAFC and FAO.

The program of the meeting included Science Board Symposium on *Methods and findings of retrospective analyses* organized by the CCCC (Climate Change and Carrying Capacity) Program and four scientific sessions: on *Regional and interannual variants in life histories of key species* (Biological Oceanography Committee), *Ecological effects of truncated age and size distribution and fishing on fish populations* (Fishery Science Committee), *Processes of contaminant cycling* (Marine Environmental Quality Committee) and *Exchange of water, organisms and sediments between continental shelf waters and the nearby ocean* (Physical Oceanography and Climate Committee). This was the first PICES Annual Meeting at which ***Best Presentation Awards*** were given and we sincerely congratulate winners: Dr. Shoshiro Minobe (Graduate School of Science, Hokkaido University, Japan) for his presentation on "*An oscillation of period 50-60 years over the North Pacific*" (Science Board), Dr. Kaoru Nakata (National Research Institute of Fisheries Science, Yokohama, Japan) for her presentation on "*Long-term fluctuations in the food availability for Japanese sardine larvae on the coastal side of the Kuroshio*" (BIO), Dr. Richard Brodeur (Alaska Fisheries Science Center, U.S.A.) for his presentation on "*Distribution of juvenile pollock relative to frontal structure near the Pribilof Islands, Bering Sea*" (FIS), Dr. Yuan Gao (Institute of Marine and Coastal Sciences, Rutgers University, U.S.A.) for her presentation on "*Cycling of contaminants through the atmosphere: long range transport vs. regional deposition*" (MEQ) and Dr. Susan Allen (University of British Columbia, Canada) for her presentation on "*Shelf-break canyons: flow patterns and deep water advection during the upwelling episode*" (POC).

The Science Board reviewed the findings and recommendations of the PICES Scientific Committees, TCODE, Implementation Panel for CCCC Program and Inter-Committee Working Groups 5 (Bering Sea) and 9 (Subarctic Pacific Monitoring), discussed implementation of decisions from 1995, future perspectives for PICES, relationships with other organizations, made arrangements for future activities, established a Study Group on PICES communications needs and practices and planned the science program of the Sixth Annual Meeting. The Governing Council considered and approved Science Board and Finance and Administrative Committee recommendations.

But what real progress was made? What are the main accomplishments of PICES V? We asked Dr. Warren Wooster, PICES' first Chairman, for his comments:

(cont. on page 21)

Warren S. Wooster

This article is written by Dr. John Knauss (see below) *in appreciation and recognition of the efforts of Dr. Warren Wooster in the establishment of the North Pacific Marine Science Organization and his outstanding service to PICES over many years. In his 75th year he completed over two terms (1992-1996) as the first Chairman of PICES.*

Chairman of PICES, 1992-1996

No one has contributed more widely and deeply to the international infrastructure of marine science than Warren Wooster, and it is unlikely that anyone will match his record in the future. He has served as Director of the UNESCO Office of Oceanography & Secretary to the Inter-governmental Oceanographic Commission (IOC), President of the Scientific Committee on Oceanic Research (SCOR), President of the International Council for the Exploration of the Sea (ICES), and Chairman of the North Pacific Marine Science Organization (PICES).

He was the first IOC Secretary, taking that position in 1961, and it was his task to help guide this fledgling international organization during its formative years. The IOC is housed in the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the verb "housed" is used advisedly. Many within UNESCO consider IOC as simply one more division of its vast Parisian empire. Others note the desire of the IOC founders to have IOC an independent international organization, like the World Meteorological Organization. The relationship has always been ambiguous, but this ambiguity has allowed the United States and the United Kingdom to remain members of the IOC after withdrawing their support for UNESCO. Warren, as first IOC Secretary, had the task of steering the IOC through these uncharted UNESCO waters, and managed to keep the IOC firmly focused on its scientific goals and nearly free of political complications.

Dr. John Knauss received his Ph.D. from the Scripps Institution of Oceanography in 1959 (six years after Dr. Warren Wooster). His research interests have mostly concerned studies of ocean circulation and he has led about a dozen expeditions in the Atlantic, Pacific, and Indian Oceans. Dr. Knauss was the founding Dean of the Graduate School of Oceanography of the University of Rhode Island and led that program for 25 years. Under President George Bush he served as the Administrator of the National Oceanic and Atmospheric Administration (NOAA). This past year Dr. Knauss was elected president-elect of the American Geophysical Union.

Undergraduate student of the Brown University, 1940

U.S. Navy, Okinawa, 1945

Many, and I amongst them, believe that IOC's finest hours were its earliest. It was under IOC auspices that the International Indian Ocean Expedition (IIOE) was organized. Some 40 ships and 23 nations participated in this 1962-64 effort to study what, at that time, was the least understood of our major oceans. Although the 1958 International Geophysical Year may have had more ships and wider participation, nothing of this scale, with its focus on a single area and a single set of problems, had ever been attempted by the marine community. It set the pattern for future focused international marine research efforts. The detailed organizational effort that led to the success of the IIOE was done while Warren Wooster was serving as first Secretary of the International Oceanographic Commission. His opportunity to participate in the IIOE came in 1964 aboard the research vessel *Argo* after he had returned as a Professor to the Scripps Institution of Oceanography.

One consequence of the International Geophysical Year (IGY) of 1957-58 was the realization that marine science as then practiced cut across the various international unions that comprise the International Council of Scientific Unions (ICSU). Oceanography was a significant part of the IGY, but planning lagged some of the other geophysical sciences, and a number of those involved in that planning prevailed upon ICSU to establish a continuing organization dedicated to international cooperation in deep-sea research, with national committees and representatives from several unions with an interest in ocean research. That organization was the Scientific Committee for Oceanic Research (SCOR) whose first task was the organization of the International Indian Ocean Expedition. In principal, the planning for the IIOE was to be done by the scientific committees of SCOR, but, since international science committees seldom control either budgets or ships, the implementation of those plans required the approval of governments, and that meant approval of the IOC.

This symbiotic relationship worked well during the early days of both organizations when both were small, and a number of representatives were members of both organizations. When Wooster left the IOC in 1963 to return to Scripps, he was immediately made a U.S. member of SCOR, and almost immediately became SCOR Secretary, a position he held for four years. In 1968 he was elected President of SCOR, and served as SCOR President from 1968 to 1972. There was no full-time SCOR Executive Secretary in those days which meant the officers did all the work; nonetheless this period saw a rapid growth of SCOR working groups

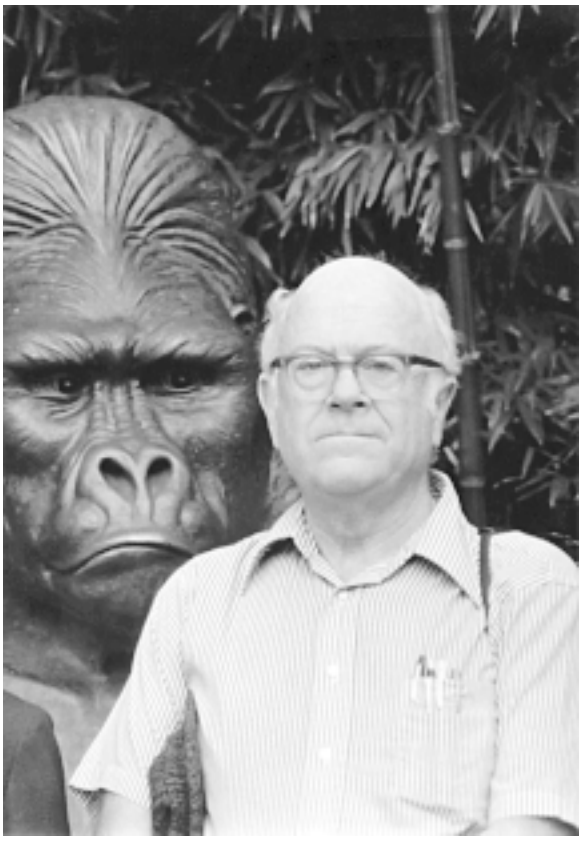
On the Northern Holiday Expedition (manganese concretion), Gulf of Alaska, 1951

and a vastly increased involvement of the marine community in SCOR activities.

Warren's next major international committment was the International Council for the Exploration of the Sea (ICES). I remember as a young graduate student reading some reference to ICES in The Oceans, that magnificent text by Sverdrup, Johnson and Fleming from which most of my generation, in the United States at least, had their introduction to oceanography. I also remember how surprised I was when, a few years later, I learned that the "sea" of ICES was limited in large measure to the North Sea and its environs. Although the United States was a member for a brief time before World War I, ICES was essentially a northern European club dedicated, as it had been from its beginning in 1902, to understanding the fisheries and oceanography of the Baltic, the North Sea, and the northeast Atlantic.

As the fishing areas of ICES members expanded after World War II, so did the ICES domain, and in 1973 the United States rejoined. Canada having also joined ICES, its focus was significantly broadened. (Another PICES member, Russia, is also a member of ICES.) Each member has two Delegates (although many more scientists serve on ICES committees), and in the United States, at least, traditionally one of those two Delegates is a government representative and one a non-government or academic member. Fortuitously, Wooster had changed oceans the same year, becoming Dean of the University of Miami's Rosenstiel School of Marine and Atmospheric Science, so, of course, he became the non-government representative from the United States. In 1982 he was elected President of ICES, the first, and to date, the only United States representative to hold that position. As President he was faced with issues as mundane as bringing the central office into the computer age to renegotiating the relation of ICES to the European Economic Commission in light of the recently completed Law of the Sea Convention and the formal establishment of Exclusive Economic Zones. After his three-year term as President, Warren served a three-year term as Cha irman of the ICES Consultative Committee, which is similar in its functions to the PICES Science Board.

Secretary of IOC, UNESCO House, Paris, 1963



San-Diego Zoo, 1992

It was his ICES experience that convinced him that the Pacific Ocean would be well served by a similar institution, and with typical Wooster charm, tact, and diligence, and calling upon some 30 years of international experience, he led the effort which resulted in the establishment of the North Pacific Marine Science Organization (PICES) in 1992. It was natural that he became its first Chairman, a position he has held until 1996. PICES began with four members (Canada, China, Japan, and the United States) and expanded by fifty percent (Russia - one of the original negotiating parties and Korea formally became members) during Warren's tenure. PICES now has a wide variety of working groups on subjects ranging from data exchange to the effects of birds and mammals on marine resources, has published one review volume (on the Okhotsk Sea), and has another in preparation (on the Bering Sea). It is well on its way to achieving its goal of providing to its members the same range and quality of services as ICES.

Not all of Warren's contributions to the infrastructure of oceanography have been at the international level. He has logged a dozen years as member or chair of committees and boards of the National Research Council of the U.S. National Academy of Sciences. He chaired a federal committee charged with coordinating the use and structure of the various research vessels controlled by U.S. universities, and in the mid-seventies he served two years on the Presidentially appointed National Advisory Committee on Oceans and Atmosphere. From 1973-76 he was Dean of the Rosenstiel School of Marine and Atmospheric Sciences of the University of Miami, at the time one of the half dozen largest and most important academic oceanographic centers in the United States.

All of this was done while maintaining a continuing record of scholarly activity. His earliest papers, the first of which was published in 1949, were in chemical oceanography. About 1955 he began expanding into regional oceanography, and ten years later his first papers in fisheries oceanography began to appear. And he hasn't stopped! In 1991 he delivered a scientific paper on hydrobiological variability at a symposium honoring the 70th anniversaries of himself and four other senior ICES colleagues.

In all, Warren Wooster has published nearly fifty papers in oceanography on subjects as varied as the Somali current of the Indian Ocean and the Peru Current of the South Pacific; on techniques for measuring phosphate at sea and the definition of salinity; on the relationship of fisheries recruitment to oceanographic conditions; and whether the decline of marine mammals can be

attributed to a lack of food. In 1994 he co-authored two papers describing decadal changes in both ocean and fisheries conditions in the eastern Pacific. He has published an almost equal number of papers (forty) in marine affairs, on subjects as far ranging as law of the sea, marine resources, and international marine science institutions. And finally, he has served as editor of five books on oceanography and marine affairs. In sum, he has a record as a publishing scholar that stretches over more areas and more years than all but a very few, and it is a record established while leading the life of one of this era's premier contributors to the health and well being of international ocean science.

Like most of his generation of oceanographers, Warren Wooster became one almost by chance. He was an undergraduate chemistry student at Brown University, but upon graduation found himself in the U.S. Navy in the middle of World War II. After three years in the Navy he found the graduate chemistry laboratories at the California Institute of Technology too confining and followed one of his Brown professors to the Scripps Institution of Oceanography. He was the only student in chemical oceanography when he arrived in 1947.

Surplus naval vessels became research ships after World War II, and suddenly doing research at sea became possible, but few had any experience. Professors and students all learned together, and Warren soon became one of the best. When I arrived as a student at Scripps in 1951, Warren, still without his PhD, had already led one major expedition to the Gulf of Alaska and was about to lead another to the eastern tropical Pacific, a region where he would make a number of significant contributions over the next twenty years. Much of what I learned about being an expedition leader I learned on that first cruise with Warren. We all knew our responsibilities, and Warren made a point of knowing what each of us was doing. He continued to spot check all the data and oversee all the procedures. One quickly learns that at sea there are few opportunities to repeat botched observations. They are either done correctly, or one must wait for the next ship. Between 1950 and 1970, Warren Wooster led seven oceanographic expeditions, spending more than a year at sea. He never came home empty handed.

During his long and illustrious career Warren Wooster has contributed much to the health and well-being of our science, and he is not finished yet. Although he formally retired from the University of Washington in 1991, he still rides his bike daily to the office. In 1995 he graduated two masters degree and one PhD degree student and has recently taken on a new student. Our community is indeed fortunate that a tour in the Navy transformed a laboratory chemist to a sea-going one.

PICES Governing Council elects new Chairman

Dr. William G. Doubleday of Canada is the new Chairman of the North Pacific Marine Science Organization. He received a B.Sc (Hon) in mathematics and chemistry from the Queens University at Kingston in 1969 and M.Sc (1971) and Ph.D. (1973) degrees in probability and statistics from the University of Sheffield. Dr. Doubleday joined the Public Service in 1973 as a Research Scientist at St. Andrews Biological Station (Department Fisheries & Oceans), New Brunswick. He was Director of the Fisheries Research Branch (DFO) from 1981 to 1986 and Chairman of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) from 1983 to 1984. From 1986 to 1991 Dr. Doubleday worked as Director, Policy and Program Coordination for Science and from 1991 to 1994 as Director General, Policy and Strategy Directorate for Science. He served as Acting Assistant Deputy Minister, Science from May 1988 to February 1990, and from January 1992 to June 1994. Currently, Dr. Doubleday is Director General, Fisheries and Oceans Science Directorate.

Interaction between the northern North Pacific and its marginal seas: current activities of JAMSTEC in the PICES region

Takatoshi Takizawa
Ocean Research Department
Japan Marine Science and Technology Center
2-15, Natsushima, Yokosuka 237, JAPAN
E-mail: takizawat@jamstec.go.jp

Dr. Takatoshi Takizawa is Head of the Arctic and Subarctic research group of the Ocean Research Department at the Japan Marine Science and Technology Centre. His recent activities include: (1) Arctic oceanographic research (a cooperative program with Woods Hole Oceanographic Institution) using a fully automated Ice-Ocean Environmental Buoy (IOEB) to understand oceanic structure of the upper Arctic Ocean, to evaluate air-sea interaction processes, and to investigate biogeochemical cycle in the Arctic Ocean; (2) study of water exchange and modification processes through the island chains (during last several summers Dr. Takizawa has been working in the Bering Sea and Aleutian Island region aboard the R/V Alpha Helix of the University of Alaska); and (3) implementation of the Sea of Okhotsk observational project.

1. Introduction

The North Pacific has two important marginal seas: the Bering Sea and the Okhotsk Sea which affect the Subarctic Gyre. They are the site of more active thermohaline forcing than the North Pacific. The cooling, sea ice production and river runoff in these seas contribute to water mass formations and modifications of the surface and intermediate water properties of the northern North Pacific.

The marginal Seas border island chains and communicate with the North Pacific through straits or passes. The Subarctic Gyre has strong flows along the North Pacific flank of these island chains. The thermohaline and biogeochemical structure of these seas are linked to the North Pacific, but little is known about the rates and their variations of mass and property exchanges. Even less is known about the processes that control flow through the passes. Recent observations indicate that the flows of the Subarctic Gyre are highly variable as eddies and meanders frequently occur. Furthermore, transport through the straits/passes can vary considerably in response to wind stress fluctuations, flow variations in the gyre and tidal currents.

Our study focuses on the interaction between the North Pacific and Bering and Okhotsk Seas, in particular water exchange and modification through the island chains. This note describes the physical setting of the study area and the current status of JAMSTEC's subarctic program.

2. Bering Sea

Exchange between the North Pacific and the Bering Sea occurs through passes comprising the Aleutian Island arc. The Alaskan Stream, the northern limb of the Subarctic Gyre, flows westward along the south side of Amchitka Pass (*Fig. 1*). A portion of this current flows northward through the pass and, on the Bering Sea side, turns eastward to flow along the north side of the Aleutian Islands as the North Aleutian Current (NAC). Observations from the Bering Sea indicate that these currents are quite variable as eddies and meanders

frequently occur. Similarly, transport through some of the passes can change markedly in response to wind stress fluctuations or flow variations in the Alaskan Stream.

Figure 2 indicates monthly maps of the SSHa (sea surface height anomaly) field showing the Alaskan Stream eddy, flow through Amchitka Pass, and circulation in the Aleutian Basin. The June 1987 map suggests that circulation in the southern Aleutian Basin is more cyclonic with southward flow through the pass. This anomaly

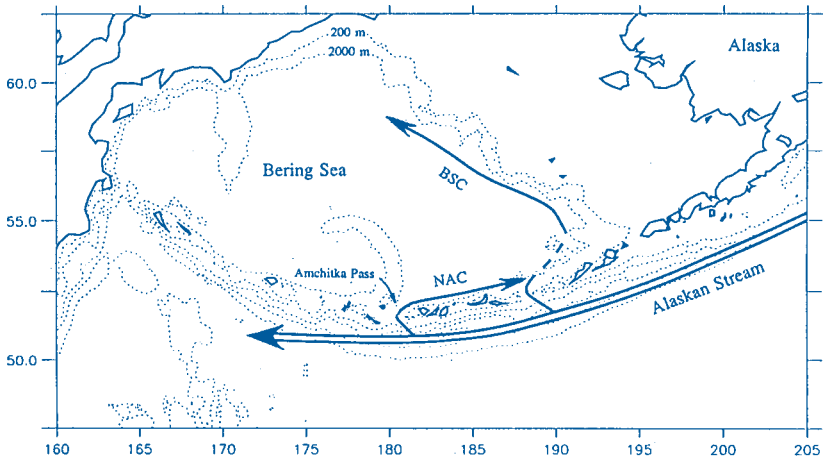


Fig. 1. Circulation schematic of the Bering Sea region; North Aleutian Current (NAC); Bering Slope Current (BSC).

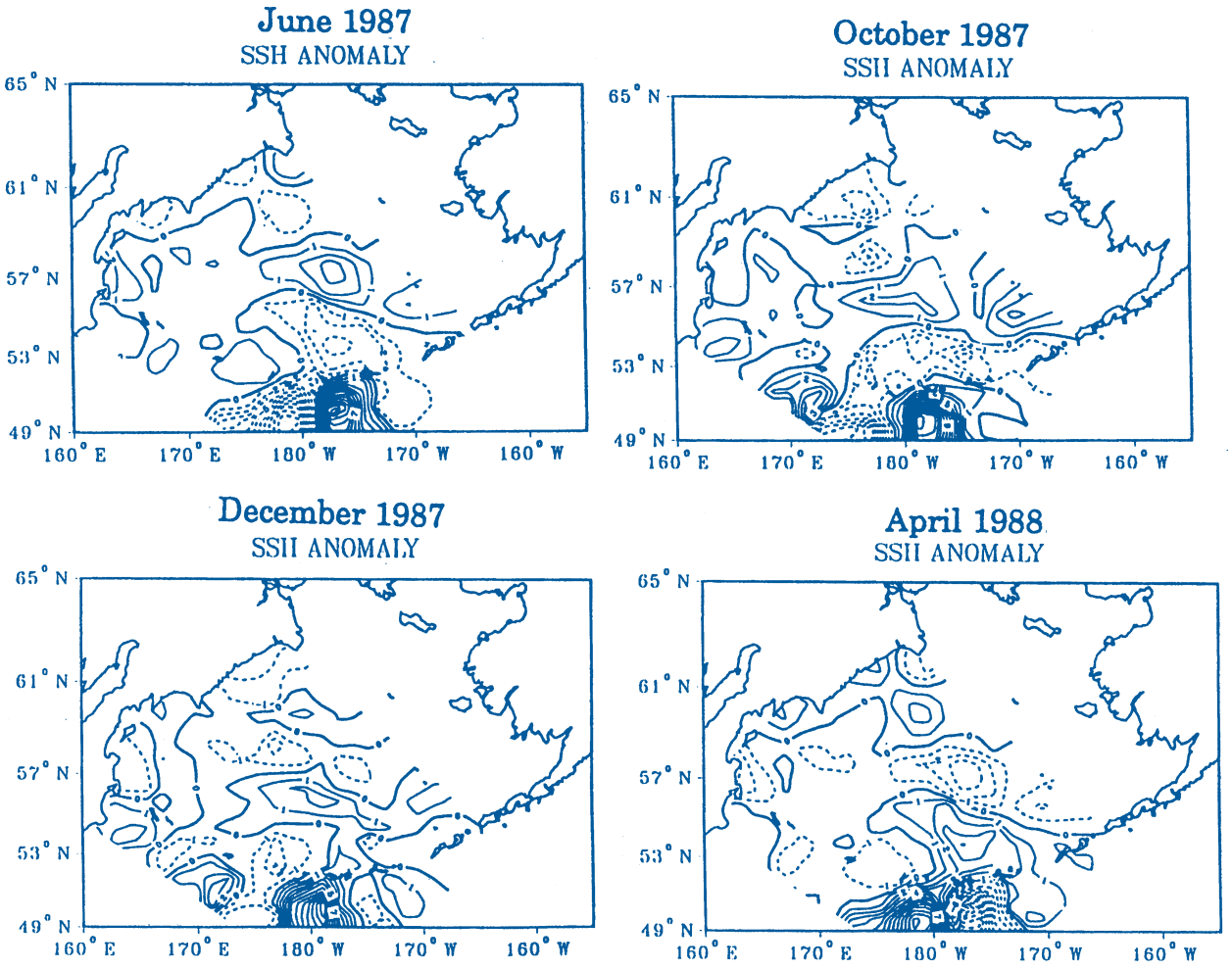


Fig. 2. Sea Surface Height anomaly field. Solid lines are positive anomalies and dashed lines are negative anomalies. The contour interval is 1cm (from Okkonen, 1996).

moved from east to west so that by December 1987 circulation in the Aleutian Basin has become anomalously anticyclonic. Independent current-meter records in Amchitka Pass from June 1987 to June 1988 indicate that there is a northward component of flow through the pass. Southward flow begins in July 1987 and continues until October 1987 when it reverses to flow northward again (Reed, 1990). The comparison of SSHa maps in the Bering Sea region with current meter records indicate that flow through Amchitka Pass responds to the transit of a large eddy in the Alaskan Stream south of the pass

3. Okhotsk Sea

It is generally understood that the subarctic North Pacific region plays an important role in climate change through processes such as the formation of North Pacific Intermediate Water (NPIW) and uptake of CO_2. However, we have little knowledge about the water mass formation and modification mechanisms along the Subarctic Gyre.

There are several ideas about the source region of NPIW with the Okhotsk Sea being the strongest candidate. However, transport and modification processes of NPIW source water formed in the Okhotsk Sea across the Kuril Islands are not well described.

Several hydrographic sections were occupied across the Kruzenshtern Strait and Bussol' (Urup) Strait during the US-Russian expedition in spring of 1995 (Riser, 1996). A CTD section across the Kruzenshtern Strait, which was carried out 3 times over a 2-day period, suggests a strong variability through the strait on time scale as short as a portion of a day. Consequently, the calculated geostrophic transport through strait is highly variable on the three surveys. Riser (1996) claimed that the flow cannot in general be geostrophic! The implication from this result is that the flow through Kruzenshtern Strait must be dominated by strong tidal flows, with the geostrophic flow being of secondary importance.

Recent numerical study including the tidal effects by Awaji (1996) demonstrates that the tide-induced mean transport shows significant net exchange of water between the Okhotsk Sea and the North Pacific via several straits in the Kuril Islands. Tracking of numerous particles in the calculated velocity field clearly demonstrates the Lagrangian movement of the Okhotsk Sea. This suggests the importance of the tide-induced outflow of the Okhotsk Sea water in formation of the Oyashio water and NPIW.

4. Approach and work plan

Our study involves observational and modeling components. The former includes combining data from satellite altimeter and current meters. The modeling efforts are devoted to the construction of a high resolution tidal model which can evaluate the water exchange through the island chains. We have conducted a CTD and hydrographic survey around the central Aleutian Islands aboard the R/V *Alpha Helix* of the University of Alaska since 1995 (*Fig. 3*). We have deployed a mooring consisting of

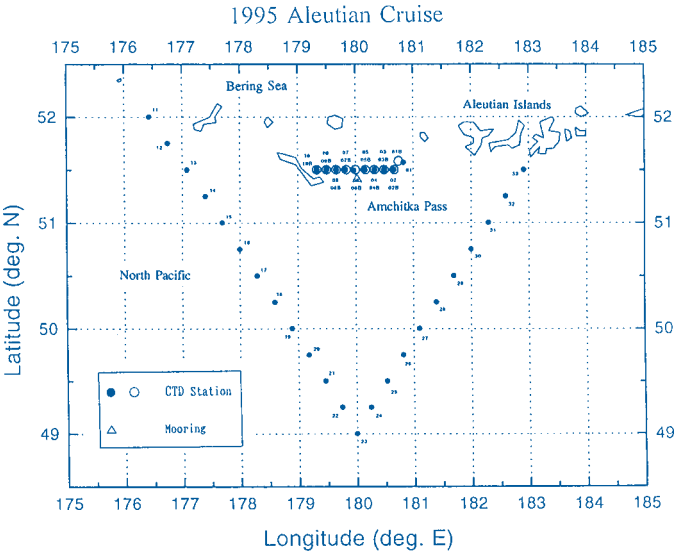
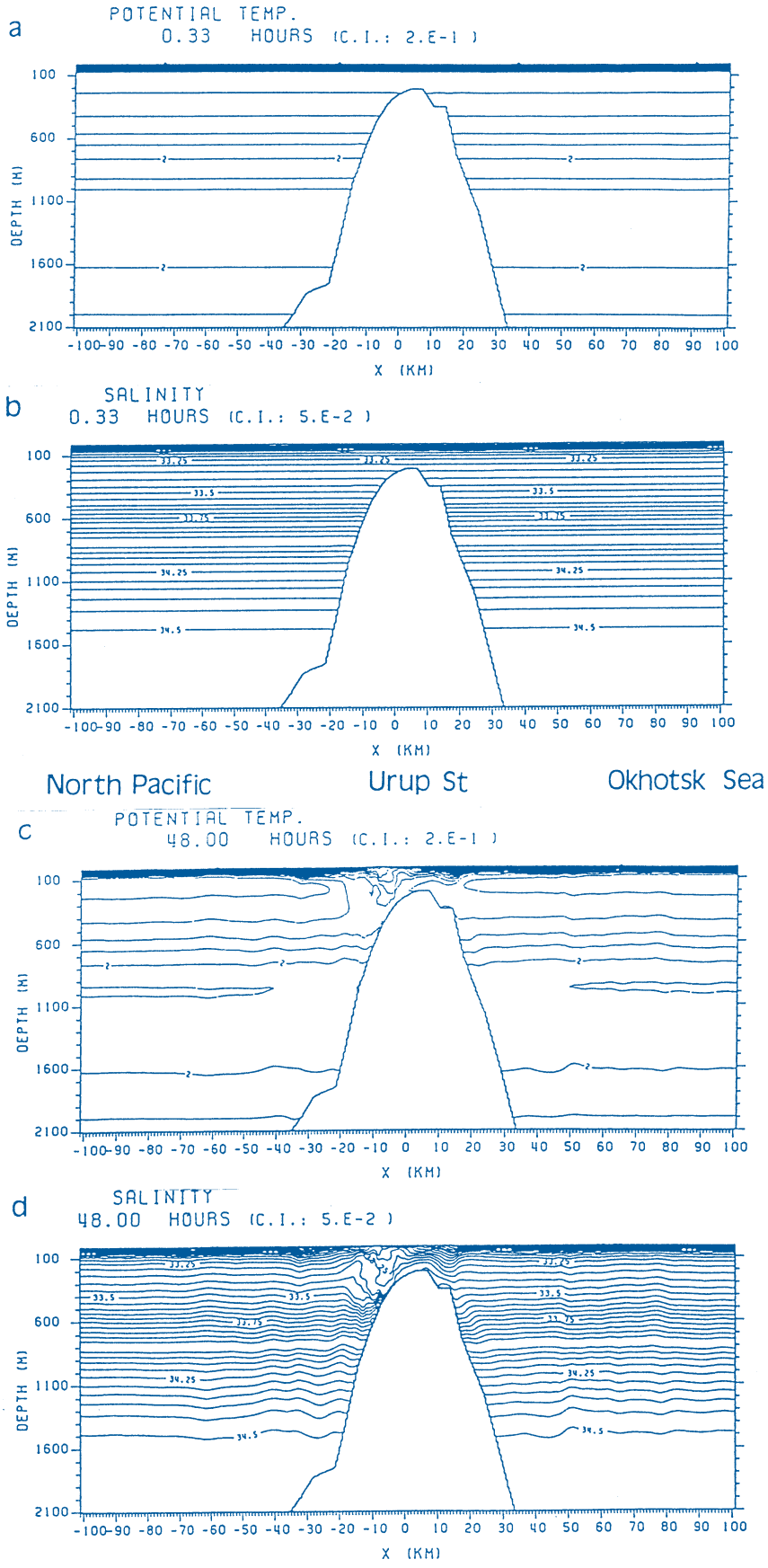


Fig. 3. Hydrographic stations of 1995 Aleutian cruise.

current meters and CTDs at Amchitka Pass. In August of 1996, the revisit of hydrographic stations and re-deploy of moorings were carried out.

As for the Okhotsk Sea, we hope to start an oceanographic observation program in 1997. Furthermore, we are developing a tidal model of the Okhotsk Sea in cooperation with the Kyoto University. Our 2-dimensional non-hydrostatic model across the Kuril Islands shows an interesting tidal mixing process around the sill (*Fig. 4*).



JAMSTEC is going to launch a new research vessel *Mirai* (8,600 gross ton) in the fall of 1997. She is capable of undertaking observation missions to high-latitude regions exposed to severe weather and sea conditions. We expect that her cruise will contribute to the acquisition of observational data necessary to understand the role of the subarctic North Pacific in climate change.

References

Awaji, T., T. Nakamura, T. Hatayama and K. Akimoto, 1996. Tidal Exchange through the Kuril Straits. Proceedings of the International Workshop on the Okhotsk Sea and Arctic, Tokyo, 1996, 168-172.

Okkonen, S.R., 1996. The influence of the Alaskan Stream eddy on flow through Amchitka Pass. J. Geophys. Res. (in press)

Reed, R.K., 1990. A year-long observation of water exchange between the North Pacific and the Bering Sea. Limnol. Oceanogr., 35:1604-1609.

Riser, S., 1996. Exchange of water between the Okhotsk Sea and North Pacific Ocean through the Kuril Straits. Proceedings of the International Workshop on the Okhotsk Sea and Arctic, Tokyo, 1996, 46-53.

Fig. 4. A preliminary result of 2-D non-hydrostatic tidal model (Nakamura et al, 1996. Private communication). Contours of the potential temperature and salinity at 0.33 hours (a), (b) and at 48 hours (c), (d)

Appendix

Japan Marine Science and Technology Center

Japan Marine Science and Technology Center (JAMSTEC) was incorporated in October 1971 by investments of the government and industry. The government contribution of funds remained near 90% in recent years and the balance is supplied by the sponsors' group, which consists of some private enterprise and business organizations involved in such fields as shipbuilding, electricity, steel, and machinery.

JAMSTEC has four principal functions as follows:

Research & development

To promote R&D of advanced technologies on the ocean floor, surveying, data acquisition, ocean energy, and manned undersea work systems.

Training

To develop human resources by holding training courses on diving techniques and marine engineering seminars for researchers and technicians.

Technical information services

To collect and disseminate information on marine science and technology.

Operation & maintenance of facilities for public use

JAMSTEC establishes and maintains various types of large-scale testing facilities for public use. They include an undersea simulation and training facility, a high pressure test facility, and an underwater anechoic (free from echoes, designed for acoustic measurements) tank and deep sea micro organisms collecting and cultivating system, etc.

The research and development activity is divided into three categories: (1) *research of deep-sea environment,* (2) *research of ocean zones* and (3) *development and utilization of coastal zones* including development and construction of manned and unmanned deep research submersibles, studies of optical fibers for deep sea cables, optical-elector-mechanical cables for remotely-operated vehicles, remote sensing by passive microwave, oceanic applications of laser, and new data acquisition buoys.

The progress of activities in recent years are as follows:

1. Deep Sea Research

It aims at comprehensive understanding of deep-sea area by investigating the variational phenomena at the deep seafloors from the past to the present and the interactions among the accompanying physical, chemical, biological and geological phenomena. For this purpose, our research is advanced by making good use of the manned submersible systems, "Shinkai 2000" and "Shinkai 6500", unmanned vehicles, "Dolphin-3k" and "Kaiko", a deep towed survey system, "JAMSTEC/Deep Tow".

By means of long-term observations of the deep-sea area, we expect to determine precisely long-term variations on the deep seafloors undetectable by short term surveys, or to catch accurately unpredictable phenomena. Moreover, we intend to explicate the processes of materials circulation in the ocean as a whole by the investigation of the migration and diffusion processes of both terrigenous and biomassive materials into the deep sea area, and of the material fluxes supplied from the seafloor into the deep sea such as hydrothermal fluid and cold seepage. Furthermore the detailed elucidation of deep structures under the seafloor is very useful for the prediction of the crustal movement or for the reduction of disasters and so we intend to clarify the underground structures in the trench area which have a high probability of a gigantic earthquake occurrence.

2. Ocean Research

We are carrying out the following activities: the ocean observation research in the North Pacific Ocean and the Arctic, the purpose of which is to get a better understanding of the variability and the mechanism of ocean current, heat transport, air-sea interaction etc. and to clarify the primary production of the ocean as well; the development of the global ocean circulation model and the development of ocean observation technology.

‘ Tropical Region

The tropical region is the region that absorbs and accumulates most of the radiant energy of the sun, forms large ocean currents, and is characterized by heat transport by these currents, ocean atmosphere interactions and equatorial upwelling. It also brings about the oceanic change represented by ENSO

phenomena, and thus it is the driving source of the global climate change. We intend to observe ocean current changes in the Western Tropical Pacific, so as to elucidate the mechanism of changes in the Western Tropical Pacific, so as to clarify the mechanism of changes in ocean structures relating to the generation and dissipation of heat.

- Subtropical Region

The Kuroshio current transports an enormous amount of thermal energy from the equatorial region to the subarctic region. The long-term variations in this heat transport affect the climate greatly, i.e. ENSO, Asian monsoon, etc. We have set mooring buoys at the Tokara Strait and monitored the Kuroshio current passing through the strait. In addition, we have set mooring systems in Izu and Ogasawara area to investigate the Kuroshio counter-current and the structure of medium-sized eddies moving westwards along the Kuroshio counter-current.

- Subarctic Region

See pages 7-10.

- Arctic Ocean

For the purpose of clarifying the role of the Arctic region in the global climate changes, we have been conducting an air-sea interaction study in the multiyear ice area in the mid-Arctic Ocean with fully automated Ice-Ocean Environmental Buoys (IOEBs) since 1992. In addition, we have been studying shelf/shelfbreak processes in the Chukchi-Beaufort Seas. The study consists of in-situ observations with a ship in summer, deployment of moorings in the Barrow Canyon area and numerical experiments using a local ocean model.

- Research and Development of Observation Technology

u *Ocean lidar observation technology*

Ocean lidar is innovative equipment which enables us to observe the time- and the space-distribution of phytoplankton over a vast area in a short time. Phytoplankton serves as a direct indication of marine biota production. A new estimation procedure combining of ocean lidar with a satellite borne color sensor is promising. We intend to observe and estimate phytoplankton by the ocean lidar and to develop the correction technique for the satellite borne color sensor data.

u *Ocean Acoustic Tomography Technology*

The ocean acoustic tomography is a computerized tomography system by which the oceanic structure can be observed instantaneously by means of an acoustic wave. We are developing an ocean acoustic tomography system which consists of eight 200 Hz tomography transceiver systems. The system is capable of observing 1,000 km square of ocean.

3. Research and development for the utilization of coastal seas

- Development of a wave energy utilization system

To make use of coastal sea, the “MIGHTY WHALE” project is now in progress. “MIGHTY WHALE” is a floating wave power device, which can convert wave power to compressed air power effectively, and create a calm sea area behind the device.

- Cooperative programs with local governments

In order to develop and utilize the coastal sea effectively, it is necessary to consider specific local requirements and to conduct joint technology development with appropriate local users. Since 1988, we have developed a number of new technologies for the utilization of coastal seas in close cooperation with local governments. The deep sea water utilization technology is designed to effectively utilize this water for marine biological production, energy production and environmental protection. We have developed a new artificial sea bed with submerging and surfacing functions for cultivating fish and shellfish at optimum depths.

4. Ship Operation

In order to perform the aforementioned activities, JAMSTEC has a 2,000 m class research submersible vessel system (“Shinkai 2000” and support vessel “Natsushima”), a 6,500 m class research submersible vessel system (“Shinkai 6500” and support vessel “Yokosuka”), remotely operated vehicles “Dolphin 3K” (3,300 m depth capability) and “Kaiko” (11,000 m depth capability), and the ocean research vessel “Kaiyo”.

What is CREAMS?

Kuh Kim
Department of Oceanography and
Research Institute of Oceanography
Seoul National University
Seoul 151-742, Korea
E-mail: kuhkim@ocean.snu.ac.kr

Dr. Kuh Kim got his Ph.D. in 1975 from M.I.T.-Woods Hole Oceanographic Institution Joint Program of Oceanography. Currently he is Professor of Physical Oceanography at the Department of Oceanography, and Division Head of the Ocean Sciences at the Research Institute of Oceanography, Seoul National University, Korea. Dr. Kim's research interests include the meso-scale dynamics, circulation and climatic changes in marginal seas. His observations in the East Sea since 1980 have produced new findings on water masses and interannual variability in the Korea Strait and Ulleung Basin. Since the First JECSS (Japan and East China Seas Study) Workshop in 1981, he has been serving for regional cooperation in oceanographic researches as a member of JECSS Steering Committee, convener of its bi-annual workshops, and editor of its proceedings. JECSS Workshop is in a transition to change its name to PAMS (Pacific-Asian Marginal Seas) Workshop, as exchange processes between the marginal seas and the North Pacific have been recognized as important parts of its interest. He has been the chairman of PAMS-JECSS Steering Committee since 1993. Presently, Dr. Kim is a member of PICES' Physical Oceanography and Climate Committee.

CREAMS is an acronym for "Circulation Research of the East Asian Marginal Seas", which began in 1993 as an international research program to understand the water mass structure and circulation in the East Sea, also known as the Sea of Japan. The East Sea is a semi-enclosed basin, surrounded by Russia, Korea and Japan, divided into three major basins as shown in *Figure 1*: the Japan Basin in the northern half of the sea is almost 4,000 meters deep, and Ulleung Basin and Yamato Basin to the south are about 2,200 meters deep. Water exchange with the North Pacific and the Sea of Okhotsk is very limited, because the Korea, Tsugaru, Soya and Tatar Straits have sill depths of 130 meters or less.

Until recently, our knowledge of the hydrography and currents in the East Sea has been based upon the famous report of Uda (1934), who analyzed the physical and chemical data acquired in the entire East Sea in May, 1932 and introduced the schematic surface currents in the East Sea for the first time as shown in *Figure 2*. The Tsushima Current is most conspicuous as it carries warm and saline waters into the East Sea through the Korea Strait. This water flows out of the Sea through the Tsugaru and Soya Straits. The warm water from the Korea Strait occupies the upper 100 meters in the southern half of the East Sea, meeting with cold waters in the northern half of the Sea and separated by a polar front located about 40˚N. *Figure 3* illustrates the basic distribution of temperature in the upper layer. Readers are referred to an excellent article by Moriyasu (1972) for a review on the Tsushima Current.

As the Tsushima Current determines the major features of the hydrography in the East Sea, the path of the Tsushima Current has become the subject of intensive modeling experiments. The pioneering work by Yoon (1982 a-c) was followed by Kawabe (1982 a, b). These models show that the Tsushima Current splits into two or three branches as it leaves the Korea Strait: one along the Japanese coast and the other along the east coast of Korea, which has been known as the East Korean

(cont. on page 22)

HIGHLIGHTS OF THE PICES FIFTH ANNUAL MEETING

Representatives of the Governing Council: *Front row: M. Kashiwai, V. Alexander, W.S. Wooster, W.G. Doubleday, W.D. McKone, A. Bychkov. Back row: W.L. Sullivan, D. Bergamaschi, K. Hagino, J.W. Balsiger, D.B. Park, Q.S. Tang, S. Matsumura, H.T. Huh, J.C. Davis, L.N. Bocharov, L.Z. Chen, D. Goodman, M. Zhang, Chinese advisor, G.V. Goussev, Chinese advisor*

Representatives at the Science Board meeting: *C.I. Zhang, R.F. Addison, Q.S. Tang, P.A. Wheeler, P.H. LeBlond, M. Kashiwai, W.G. Doubleday, W.S. Wooster, W.D. McKone, R.M. Brown, S. Matsumura*

Major task force of the Local Organizing Committee: *A. Thompson, S. McKinnell and T. Hamer from the Pacific Biological Station in Nanaimo*

Dr. Warren S. Wooster, Mrs. Wooster and PICES Chairman-elect, Dr. William G. Doubleday, at the Extravaganza Dinner

Dr. Vera Alexander, on behalf of PICES, presents Dr. Wooster with a special souvenir, the original Indian print on the Fifth Annual Meeting poster

Dr. and Mrs. Wooster and the special gift from the chef of Malaspina University-College - the sugar Wooster 'S' fish model

Awards for the Best Presentation of various sessions on display at the Secretariat office

One small corner of the exciting poster session

Dr. S. Uye demonstrates the joy and excitement of obtaining paper abstracts at the scientific sessions

MEQ Meeting in progress

Dr. G.A. McFarlane giving a presentation at the FIS Session

Dr. K. Nakata giving her award-winning presentation at the BIO Session

Well-attended SB Symposium

Secretariat staff mingling with Russian participants at the Thanksgiving Dinner

Happy reunion of Drs. D.J. Noakes, L. Margolis, the renowned Dr. W.E. Ricker, B.N. Kotenev, R.J. Beamish and W.G. Doubleday

Chinese delegates and Prof. Y. Nagata (right most) toasting Dr. Doubleday as new PICES Chairman

The State of the eastern North Pacific in the first half of 1996

Howard Freeland
Ocean Physics, Inst. of Ocean Sciences
P.O. Box 6000, Sidney
B.C., CANADA V8L 4B2
E-mail: hjfree@ios.bc.ca

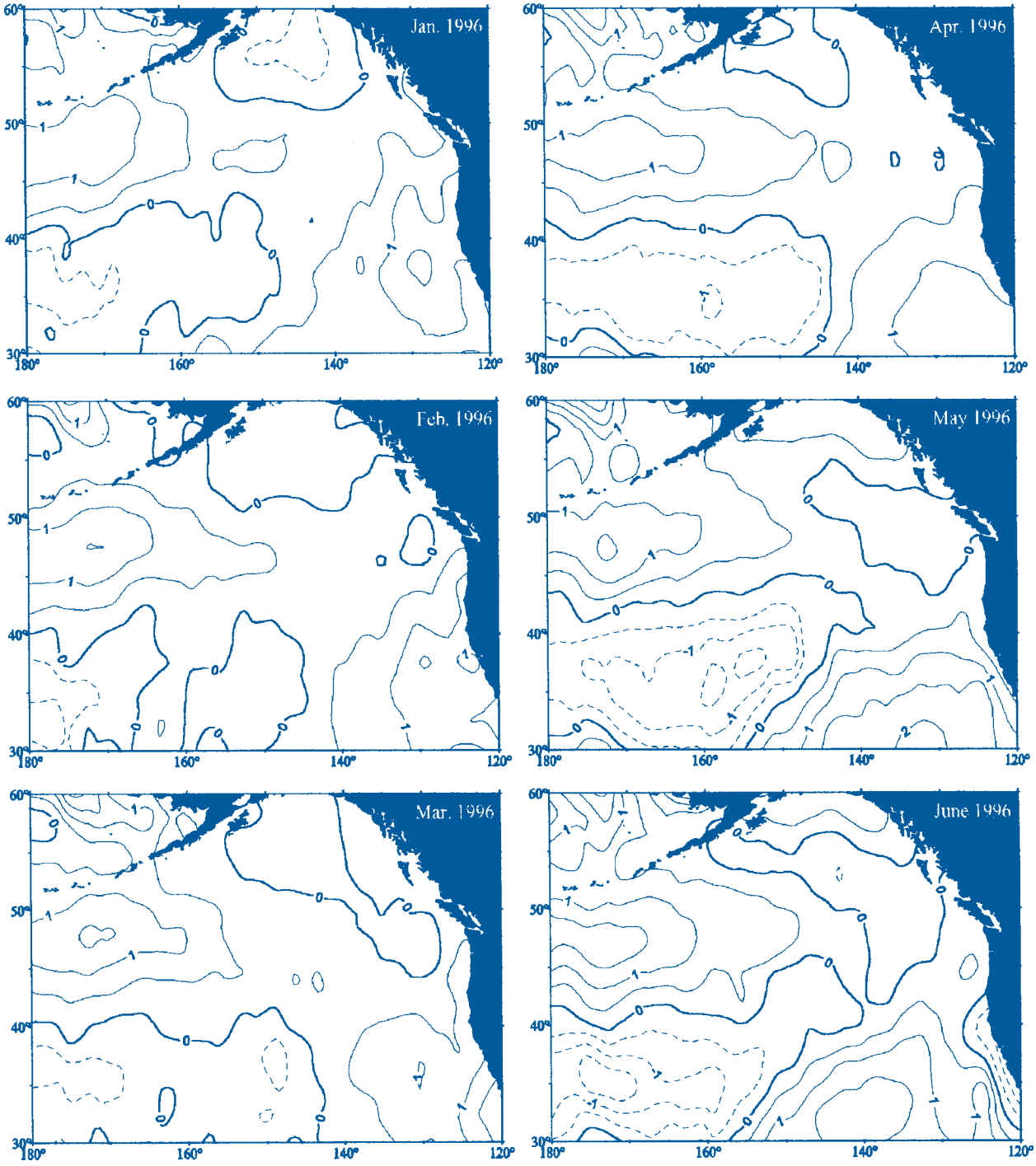
Dr. Howard Freeland is Head of the Ocean Science and Productivity Division at the Institute of Ocean Sciences (Department of Fisheries and Oceans, Canada). Dr. Freeland is interested in the climatic state of the ocean and low frequency variability. Presently, he is responsible for the maintenance of Line-P, a line of CTD stations that has been monitored for over 40 years between the mouth of the Juan de Fuca Strait and Ocean Weather Station Papa at 50˚N and 145˚W (also known as WOCE Repeat Hydrography Line PR6). Dr. Freeland was the scientist primarily responsible for Canadian interests in the WOCE Lines P15 & P1. Earlier this year he was the winner of the Applied Oceanography Prize awarded annually by the Canadian Meteorological and Oceanographic Society.

Sea surface temperatures (SST) were close to normal in the Gulf of Alaska through the first half of 1996. In the maps of SST anomalies (see *Figure*) two significant departures from the mean state appear both in the far western part of the North Pacific. The warm anomaly centered near 47˚N and 170˚W contains anomalies up to 1.5˚C above normal and is continuous with a warm anomaly appearing, but not worthy of mention, in the western Pacific maps presented by Teruko Manabe in paper on "The State of the western North Pacific in the first half of 1996" (this issue). The cold anomaly to the south of the warm anomaly appears to be the eastward extension of the cold event that dominates the maps of SST anomaly in the western North Pacific. This event affected the eastern Pacific only weakly early in the year but appeared to be growing steadily as the year progressed and in June was showing evidence of becoming the dominant influence on sea surface temperatures in the eastern North Pacific.

Within the Gulf of Alaska SST anomalies were rarely significantly different from normal. This is important for the fisheries of British Columbia as we use SST anomalies to forecast some aspects of the migration paths of sockeye salmon. Off the coast of California SSTs were significantly above normal through the early part of 1996, but a coastal cold anomaly developed very suddenly in June, most probably due to an early onset to the upwelling season.

Conditions along the west coast of the Americas are largely determined by evolving conditions in the equatorial Pacific. Late in 1995 the persistent El Niño that dominated conditions through the early 1990s relaxed, at last, to near normal conditions and early in 1996 moved into a range of values suggestive of mild La Niña conditions. Most computer models suggest that the ocean will remain somewhere between a mild La Niña condition and normal conditions through the winter of 1996/97. The implication being that we do not expect and significant anomalies to develop in the N.E. Pacific Ocean during 1997.

A longer term concern exists in the N.E. Pacific. In recent years we have seen dissolved nitrate fall to zero late in the summer along large sections of Line P (from the mouth of the Juan de Fuca Strait, 48˚30'N 124˚30'W, to Ocean Station Papa, 50˚N 145˚W). This has not happened before and suggests a change in the climatic state of the N.E. that is acting to reduce the over-winter supply of nutrients to the near-surface layers. This could have a significant impact on the ecology of the N.E. Pacific.



Monthly mean sea-surface temperature anomalies in the eastern half of the North Pacific Ocean. The anomalies are departures from a mean computed over 1982 to 1996. Contour interval is 0.5˚C, negative anomalies are shown by dashed lines, and the zero contour is shown bold.

The State of the western North Pacific in the first half of 1996

Teruko Manabe
Oceanographical Division
Climate and Marine Department
Japan Meteorological Agency
1-3-4 Otemachi, Chiyoda-ku
Tokyo 100, Japan
E-mail: t_manabe@umi.hq.kishou.go.jp

Ms. Teruko Manabe is Senior Scientific Officer of the Oceanologica Division of the Climate and Marine Department at the Japan Meteorological Agency (JMA). She is working as a member of a group in charge of monitoring and forecasting of sea surface temperature, subsurface temperature and sea surface current. Based on in situ and satellite data, this group makes different products and the JMA disseminates them by meteorological radio facsimile broadcast and by publishing the "Monthly Ocean Report". Ms. Manabe's recent activities also include the development of a new analysis system of subsurface temperature in the North Pacific to improve sea surface temperature forecasts in the western North Pacific.

In the western North Pacific, SST (Sea Surface Temperature) was below normal between 30˚N and 45˚N throughout the first half of 1996 (*Fig. 1*). In particular, negative SST anomalies colder than -1˚C prevailed in May and June. Consistent with this low SST, the 500-hPa height field over the North Pacific was dominated by below-normal heights in the middle latitudes. On the other hand, SSTs continued to be above normal north of 45˚N and south of 25˚N throughout the period (*Fig. 1*). Specifically, positive SST anomalies more than +0.5˚C have dominated the western tropical Pacific since August 1995.

The Kuroshio Current has continued to take non-large-meander path along the south coast of Japan since the summer of 1991.

Sea ice area in the Sea of Okhotsk was narrower than normal during the winter of 1995/1996 (*Fig. 1*). The last eight consecutive winters recorded less annual maximum sea ice areas than the long-term mean (1971-1990).

In contrast to the western tropical Pacific, SST was continuously below normal in the eastern equatorial Pacific from the autumn of 1995, indicating a cold episode in the tropical Pacific. However, SST in the western tropical Pacific continued to be markedly warmer than normal as mentioned above, while the magnitude of negative SST anomalies of the eastern equatorial Pacific diminished from the spring of 1996. For example, monthly mean SST anomaly averaged for the area 0˚N to 14˚N and 130˚E to 150˚E, which is one of the ENSO related indices used in the Japan Meteorological Agency (JMA), has been the maximum recorded in each month. Monthly mean SST data are available from 1949 in JMA and such prolonged large positive SST anomalies have not been observed before.

R/V *Ryofu Maru* of JMA has been making hydrographic observations along 137˚E from the south of Japan to the equatorial region (often down to 3˚N) in summer since 1967 and in winter since 1972. In contrast to shallow warm water in January 1995, subsurface temperature observations collected in January /

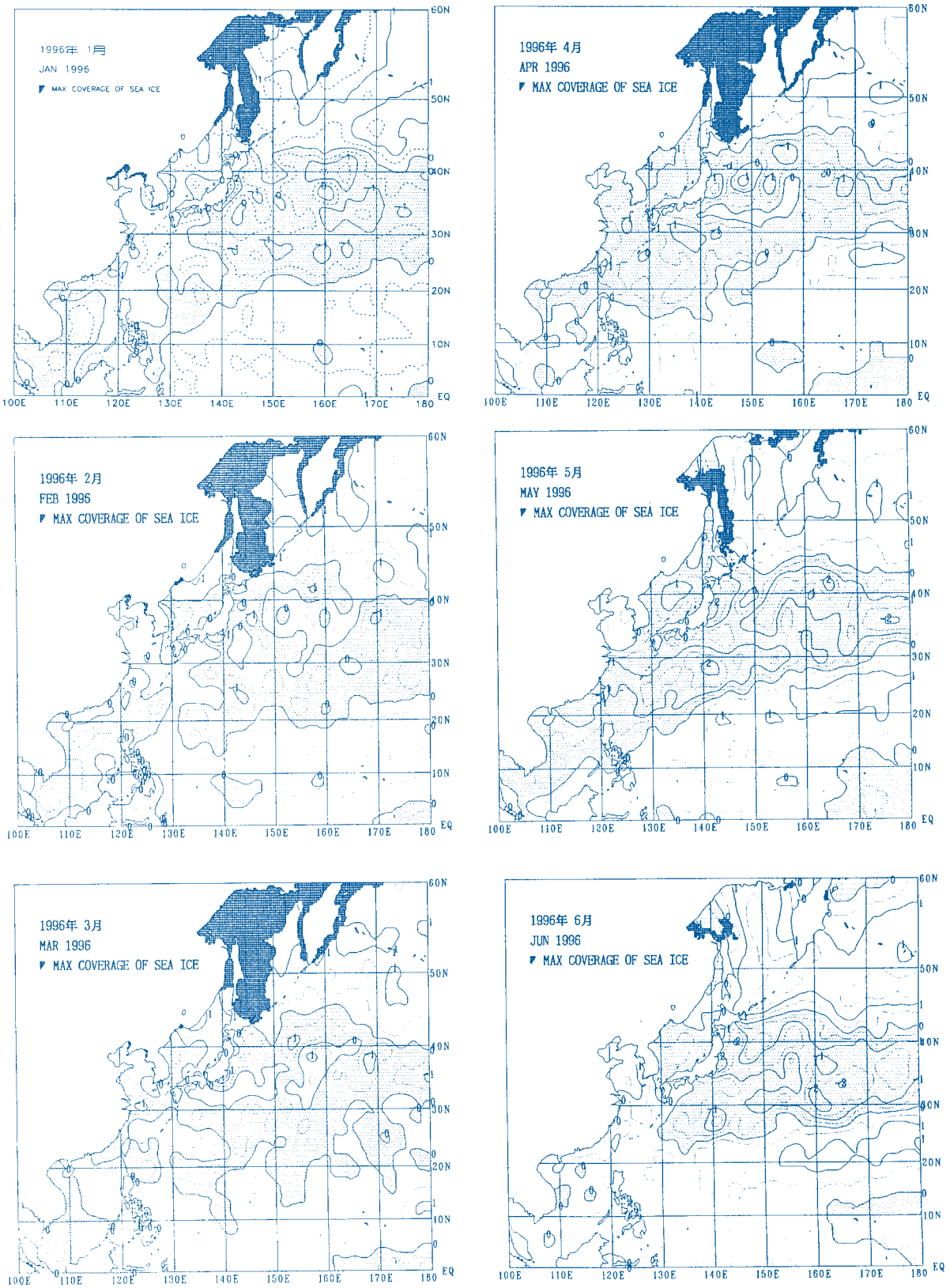


Fig. 1. Monthly mean sea surface temperature anomalies. Anomalies are depatures from the JMA Climatology (1961-1990). Contour interval is 1˚C and additional contours of 0.5˚C are shown as broken lines. Negative anomalies are shaded.

February 1996 (*Fig. 2*) showed that warm water over 28˚C extended down to a depth of about 100 m south of 5˚N, showing the subsurface structure in the western tropical Pacific typical of a cold episode. However, positive anomalies were found less widely and the maximum of positive anomalies was smaller this January/February than in January 1989, during the latest strong cold episode.

According to R/V *Ryofu Maru* observations in July 1996 (*Fig. 2*), the thermocline depth was shallower than normal between 10˚N and 4˚N and negative

subsurface temperature anomalies of -1˚ to -3˚C were observed from the depth of 50 to 250 m. This is in contrast to her observations in January/ February 1996, when positive subsurface temperature anomalies more than 1˚C prevailed south of 9˚N reflecting a deeper-than-normal thermocline depth, and is consistent with the weakening of the recent cold episode. However, only near-surface temperature remains warm in the western tropical Pacific.

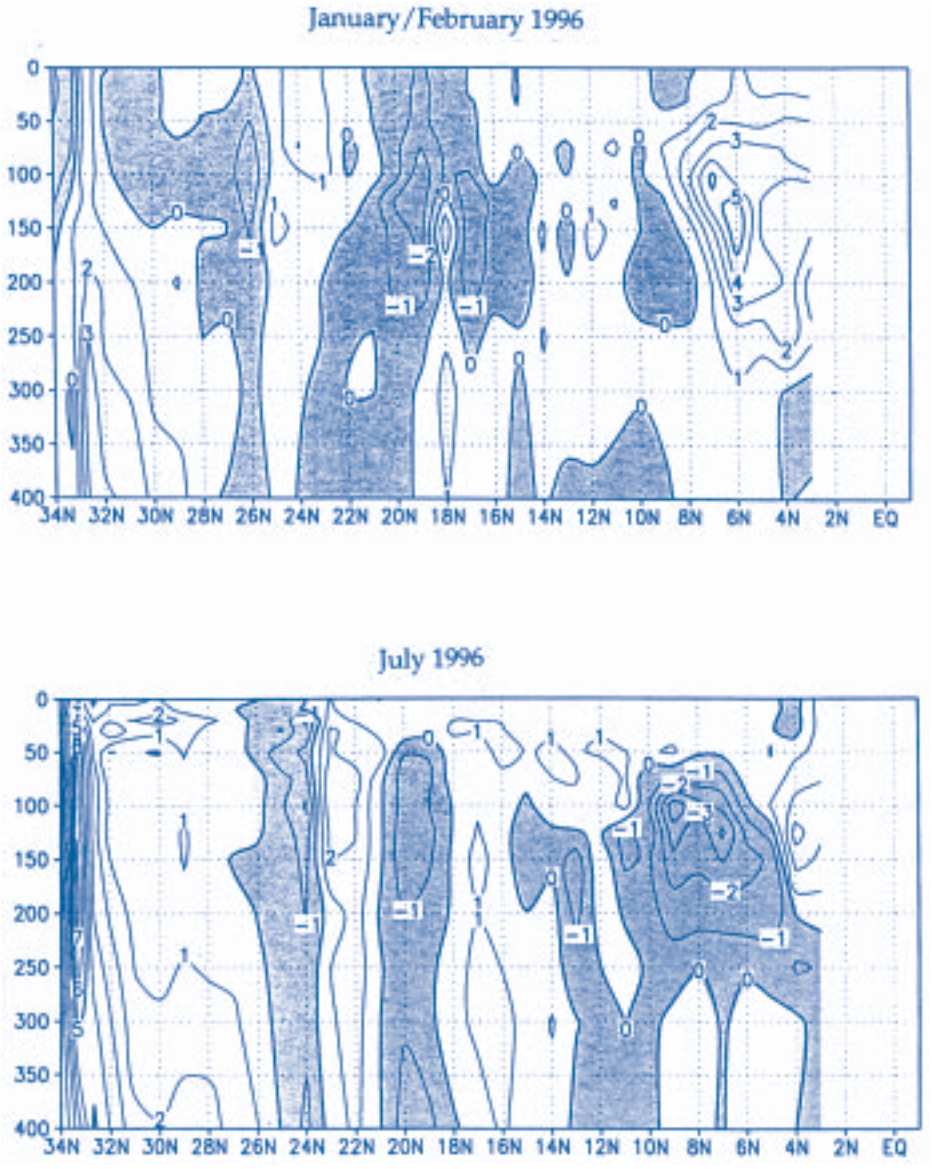


Fig. 2. Depth-latitude sections of subsurface temperature anomalies along 137˚C for January/February 1996 (top) and July 1996 (bottom) observed by R/V Ryofu Maru. Negative anomalies are shaded. Anomalies are departures from 1967-1990 base period means.

(*cont. from page 1*)

As retiring Chairman, I was asked to comment on the state of PICES at the end of its Fifth Annual Meeting. PICES V had all the attributes of a successful scientific meeting - strong attendance, good scientific sessions with interesting papers, and perhaps most important, the opportunity at the outstanding social occasions and in between sessions to exchange views and try out new ideas on peers. In another, somewhat less visible, dimension, the discussions of Working Groups and Scientific Committees, and subsequently the Science Board, assessed the work of the past year and the plans for the future. Ultimately, the Governing Council made the decisions that carry on the work up to PICES VI and beyond.

The broadest scientific enterprise in which PICES is involved is the study of Climate Change and Carrying Capacity, the so-called CCCC program. The research is concerned fundamentally with examining the effects of climate variations on the large oceanic ecosystems of the northern North Pacific. Such an effort requires the participation of meteorologists, oceanographers of all varieties, and fishery scientists, especially those that take the ecosystem approach to examining the causes of fish stock fluctuations.

It should be noted that fishing itself is also an important cause of stock changes, and PICES decided to work with the Scientific Committee on Oceanic Research (SCOR) on this aspect of the problem through participation in the SCOR Working Group (WG 105) on the Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems.

The CCCC advanced during 1996 through its Workshop on Conceptual-Theoretical Studies and Model Development in June and continuation of planning for work on the regional and basin scales, through the REX and BASS Task Teams. New Working Groups on marine birds and mammals (WG 11) and on crabs and shrimps (WG 12) will strengthen consideration of those elements of the food webs. The CCCC also depends on the support of the Technical Committee on Data Exchange (TCODE) and the ongoing monitoring study (WG 9). Meanwhile, it is hoped that recommendations of the Bering Sea Working Group (WG 5) will lead to development of a Bering Sea component of the regional scale studies. During the next year, there will be further planning, a REX workshop and meetings of the other planning elements with a view to seeing some field work initiated in the following year.

In considering the importance of interdisciplinary work, the Science Board and Governing Council recognized that in some countries, the lead agency in dealing with PICES did not include in its own work the broad range of necessary scientific activities, so that strengthened interagency coordination was needed to bring all the national elements into the PICES work. Hence the Governing Council agreed to encourage establishment in each member country of an interagency coordinating mechanism whereby participation of all interested parties can be arranged (Decision 96/S/6).

PICES had previously reviewed the status of scientific efforts in the Okhotsk Sea and was now looking at possible cooperative efforts in the Japan/East Sea (WG 10). These considerations have revealed that access for research purposes to waters under national jurisdiction was not automatic, and even sometimes difficult to arrange. Some guidance on these problems was provided by the United Nations Convention on the Law of the Sea, particularly its Article 247 which deals with cooperative projects developed under the auspices of international organizations. The Governing Council agreed to affirm application of this article to PICES cooperative projects. For this purpose, research plans of Working Groups should be reviewed and approved by the Science Board and forwarded to the Council for endorsement by the Organization. Further, Working Groups were asked to identify elements of research programs where questions of access might arise.

Although PICES is formally less than five years old, its origins go back nearly twenty. With the election of a new Chairman, Dr. W. Doubleday (Canada), it is time for PICES to move on to the next phase which should be characterized by full participation of all scientists in member countries concerned with advancing scientific knowledge of the northern North Pacific and its living resources. With this, implementation of many of the ideas that have emerged during the first years can be anticipated. It has been my dream that PICES would become the central forum for the international discussion of marine scientific questions in that region, and a mechanism for helping to satisfy the scientific aspirations of its members. I intend to continue working toward fulfillment of that dream.

Warren Wooster

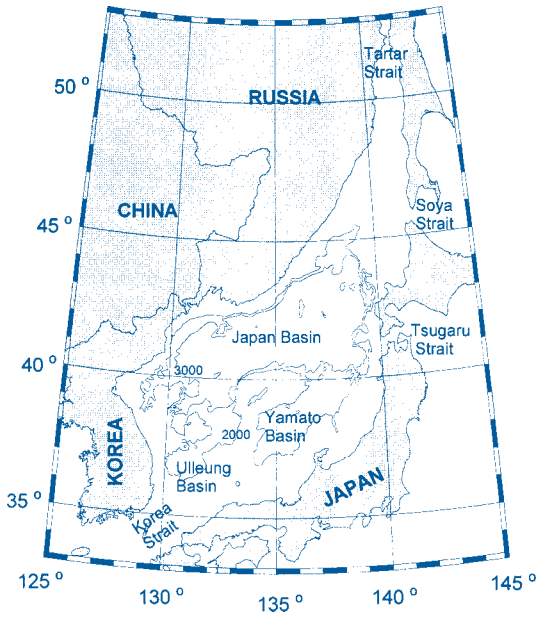


Fig. 1. Geographical names and bathymetry of the East Sea. Isobaths of 2,000 m and 3,000 m are indicated.

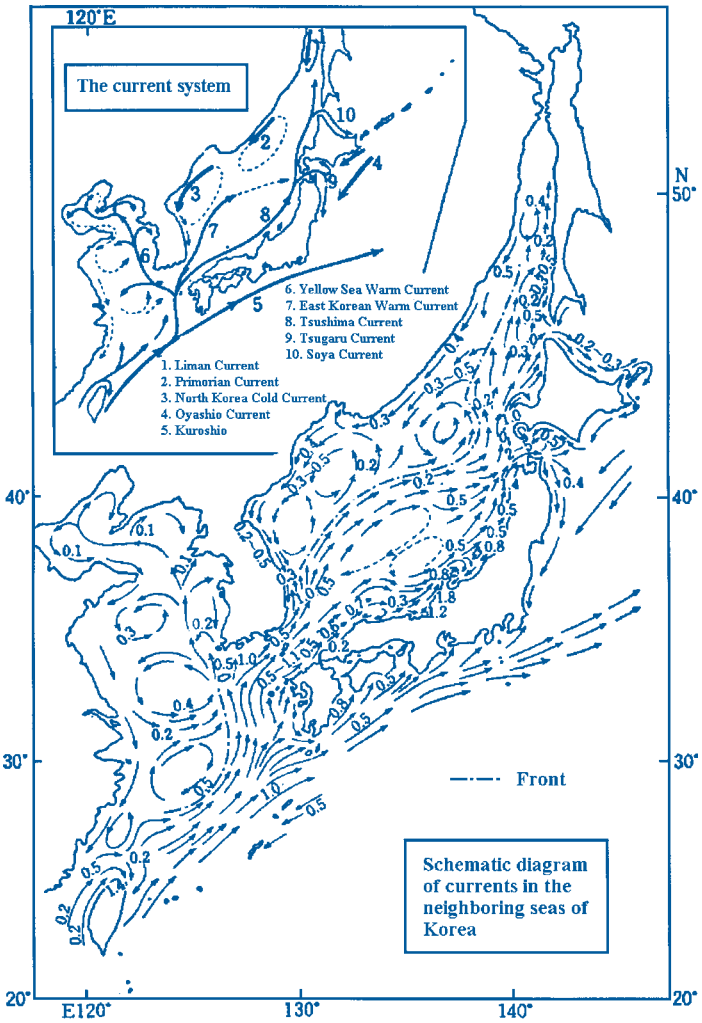


Fig. 2. Schematic diagram of currents in the neighboring seas of Korea, adopted in English from Uda (1934).

(cont. from page 13)

Warm Current (EKWC) after Uda (1934); a third branch appears between the first two branches when the transport of the Tsushima Current through the Korea Strait increases substantially in summer.

Noting the presence of abundant cold water with temperature below 1˚C, Uda (1934) called this water "East Sea Proper Water" (ESPW), which makes about 86 % of the East Sea (Yasui, et al, 1967). In *Figure 3* we can see that the water at 300 m is completely isolated from the North Pacific and the Sea of Okhotsk with a nearly constant temperature at 1˚C in the northern part and slightly higher in the southern part. Since Uda (1934), it has been well known that these cold waters are very high in dissolved oxygen (DO). At 300 m DO concentration varies in the range of 5.5-6.5 ml/l in the East Sea, whereas it is about 5.0 ml/l or less in the North Pacific. It is most interesting that DO remains very high in deep waters of the East Sea as shown in *Figure 4*, but has a concentration of only about 1.5 ml/l in the North Pacific. Because of this high concentration an active ventilation process in the East Sea has been assumed, although little is known on where and how such cold waters are formed in winter and under what conditions.

The temperature of the bottom water in the Korea Strait is usually as low as 5˚C or less in summer and as high as 12˚C in winter (Lim and Chang, 1969). However, the origin of this cold water could not be traced until the peculiar characteristics of salinity minimum and dissolved oxygen maximum were found under the warm water near the Korea Strait in 1981 by Kim and Chung (1984). They named this water "East Sea Intermediate Water" (ESIW). Furthermore, the EKWC did not appear at all in 1981 (Kim and Legeckis, 1986), contradicting historical knowledge and the results of numerical experiments. These observations indicate strongly the possibility that even the path of the Tsushima Current is closely related to the presence of the cold water.

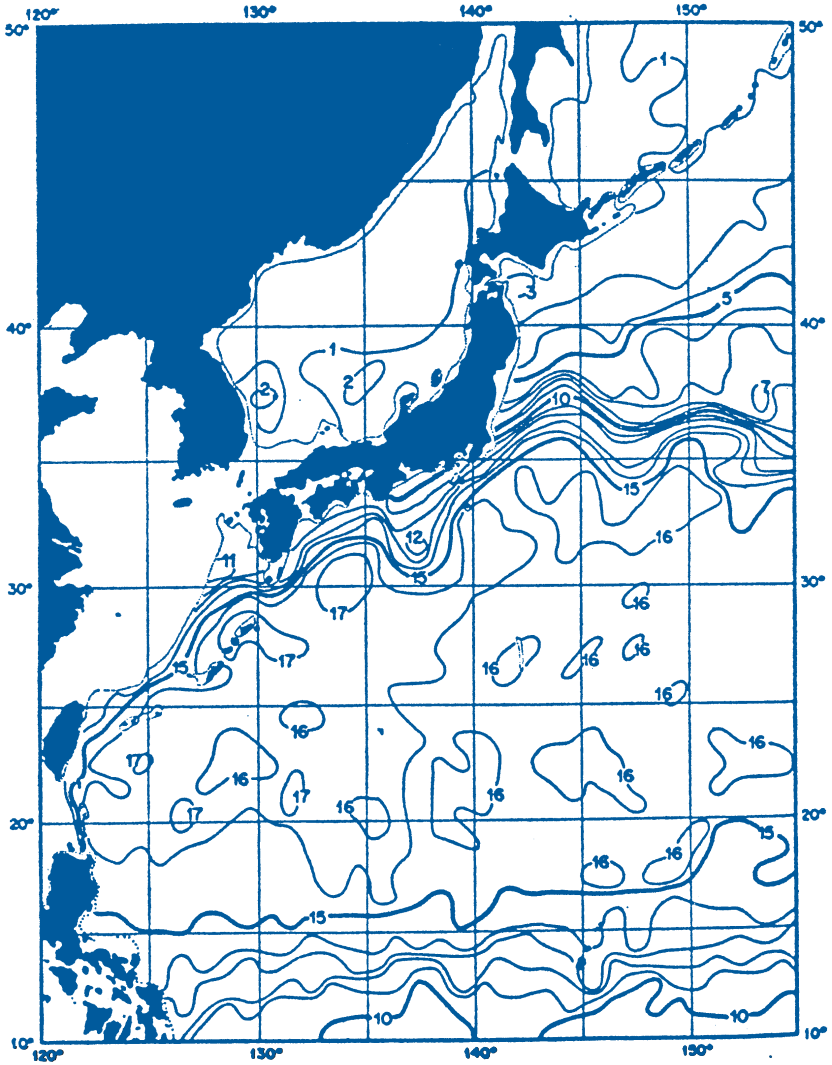


Fig. 3. Distribution of temperature (℃) at 300 m from Winterfeld and Stommel (1972)

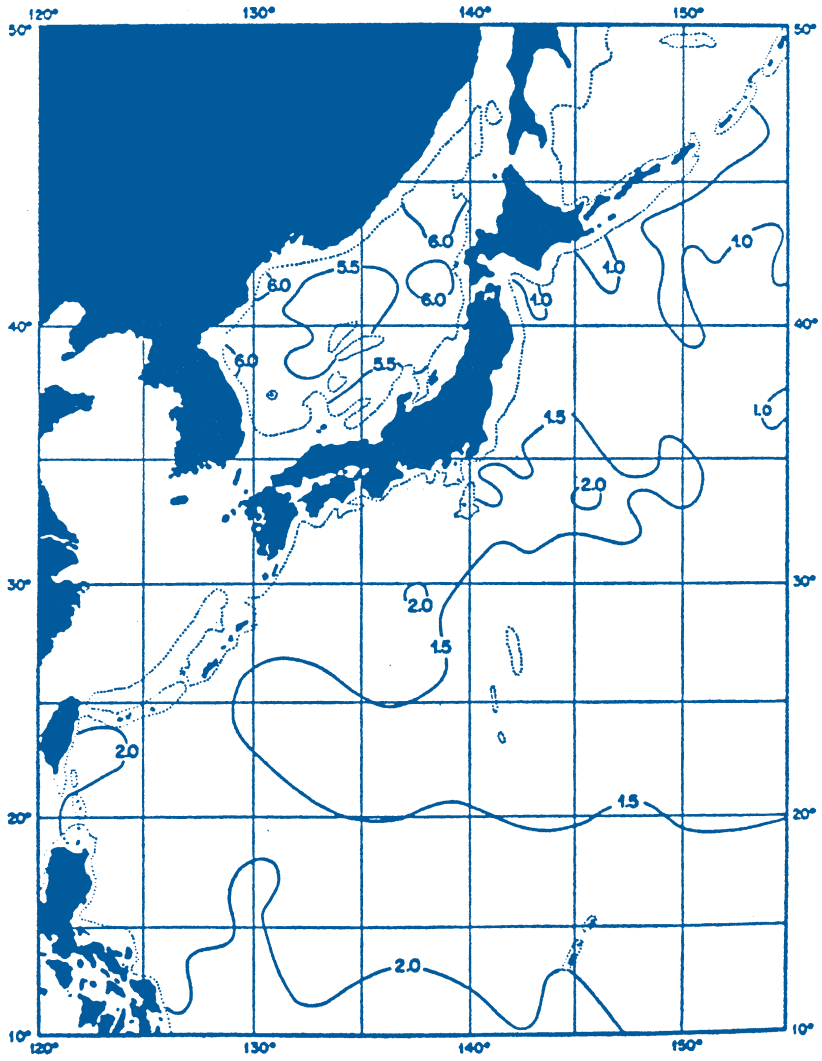


Fig. 4. Distribution of dissolved oxygen (ml/l) at 1000 m from Winterfeld and Stommel (1972)

Thus, critical questions have been raised concerning the circulation of the cold waters in the East Sea and dynamics governing the path of the Tsushima Current. CREAMS has been organized to address the following fundamental questions:

- Where are the areas of cold water formation in winter?
- What is the circulation in the northern half of the East Sea?
- What are the precise characteristics of waters in the East Sea?
- What is the coupling mechanism between the warm current and the circulation of cold waters?

CREAMS is comprised of analysis of historical data, field observations, numerical modeling, and laboratory experiments. To answer the above questions scientists from Japan, Korea and Russia are joining together, led by Prof. M. Takematsu and Dr. Yu. Volkov, at following addresses, with the author of this article:

Prof. Masaki Takematsu
Director, Research Institute for Applied Mechanics
Kyushu University
Kasuga, 816 Japan
E-mail: takematsu@hikari.riam.kyushu-u.ac.jp

Dr. Yuli N. Volkov
Director, Far Eastern Regional Hydrometeorological Research Institute
24 Fontannaya St.
Vladivostok 690600, Russia
E-mail: fehri@stv.iasnet.ru

Since its beginning there have been four joint, multinational cruises in summer and two cruises in winter, four workshops and one international symposium. Proceedings of the First CREAMS International Symposium, and the 3rd and 4th workshops have been very useful in communicating progress in all areas of interest to CREAMS. Numerical models have made rapid progress, such as Kim and Yoon (1994), whose Ocean General Circulation Model successfully captured some important features of the surface and intermediate circulations in the East Sea; the gradual transition of the Tsushima Current along Honshu from the branching path in spring to the eddy-rich meandering path in autumn, movements of the ESIW in the western half of the East Sea, and its coupling with the EKWC which recirculates in the Ulleung Basin.

The following summarizes the observational programs. *Figure 5* shows CTD and chemistry stations taken in the summer of 1993, together with locations of moorings, deployment positions of satellite drifters and lines of towed ADCP. Although the locations of hydrographic stations and moorings have been changed slightly each year due to some restrictions, it should be recognized that hydrographic data of highest precision were collected in most parts of the East Sea more than half a century after the historic report of Uda (1934). Previously as part of the Cooperative Study of the Kuroshio (CSK), hydrographic surveys, organized by the Intergovernmental Oceanographic Commission, were conducted mainly in the southern warm region of the East Sea in 1965-1970. For the purposes of CREAMS the northern cold region has been the area of main interest. In particular, deep stations and long-term current data became available for the first time in this region.

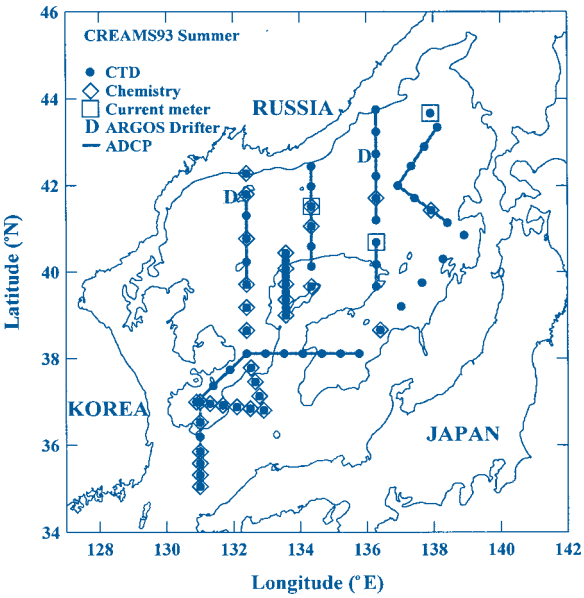


Fig. 5. Station map for CREAMS cruise in July 1993.

The preliminary analysis of CREAMS data has revealed some fascinating new findings and two examples are introduced briefly here. *Figure 6* shows a broad minimum centered at about 1,500 metres in vertical profiles of salinity taken in the Japan Basin (Kim et al., 1996). Such a minimum was first found in 1994 and its presence was confirmed at most stations in the Japan Basin in 1995. Since a salinity difference of only 0.002 psu accounts for this minimum, it may have been very difficult to observe this structure from bottle stations in the past. A deep salinity minimum has been observed in the open ocean such as in the South Pacific during

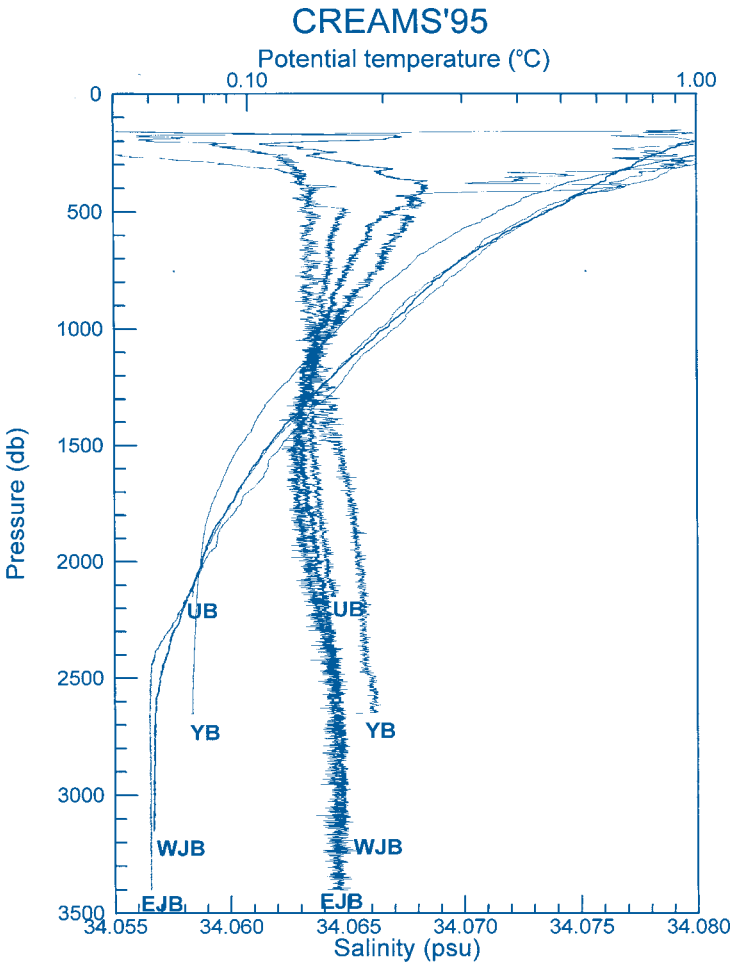


Fig. 6. Vertical profiles of temperature and salinity taken in the eastern and western Japan Basin (EJB and WJB), Ulleung Basin (UB) and Yamato Basin (YB) from Kim et al. (1996)

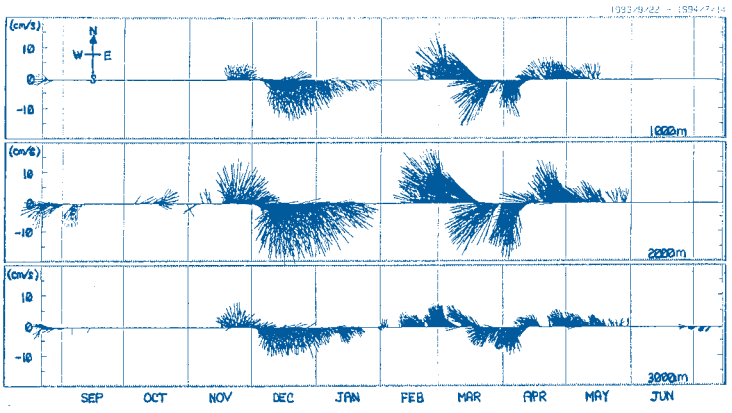


Fig. 7. Time series of currents at nominal depths of 1,000 m, 2,000 m and 3,000 m taken in the central part of the Japan Basin from Takematsu et al. (1994)

GEOSECS, but its scale of difference is two orders of magnitude larger.

It is very interesting that DO also has a minimum a few hundreds metres below this deep salinity minimum. In fact, the layer of DO minimum has deepened as DO contents has increased (decreased) significantly above (below) this layer continuously at least for the last 30 years (Gamo and Horibe, 1983; Gamo et al., 1986). These accompanied with other changes such that temperatures at 1,000 metres and in the bottom water have increased by 0.1 and 0.02˚C respectively All these observations seem to indicate that the mode of deep water formation has switched from bottom water formation to deep water formation in recent years, possibly reflecting a regional effect of the global warming.

It is fascinating to examine the first long-term time series of currents taken in the Japan Basin, shown in *Figure 7* (Takematsu et al., 1994). At nominal depths of 1,000, 2,000 and 3,000 meters low-passed currents are very weak until November, but suddenly strong currents of 15-20 cm/sec began to fluctuate with a time scale of a few weeks to months, lasting through the following spring. Other moorings also indicate unsteady, strong currents. The detailed structure of water masses and energetic currents in deep waters together with the complexity of satellite images strongly indicate that our knowledge of currents and circulation in the East Sea is rather limited and inadequate. The structure of deep waters and detailed meso-scale variations of properties and currents are subject to further careful and rigorous investigation.

CREAMS is now in an analysis and synthesis phase of the data collected in the last four years. At the fourth CREAMS workshop held in Vladivostok, February 12-13, 1996, the progress of CREAMS was evaluated and it was recommended to expand it. Accordingly, CREAMS-I will be completed in 1997 and followed by CREAMS-II beginning in 1998 for

another five years. CREAMS invites new research programs and we hope to carry out an intensive observation program in 1999 - 2000, involving simultaneous multi-ship surveys in the entire East Sea and direct measurements of current fields utilizing both Lagrangian drifters and current meter moorings at key locations. It is very much desired to coordinate these efforts with NEAR-GOOS (NorthEast Asian Regional-Global Ocean Observing System) so that interior processes and boundary conditions can be related at the end of the program. Eventually we might be able to forecast short and long-term changes of the ocean environment in the East Sea.

From the conception of CREAMS until now, the enthusiasm and devotion of Prof. Masaki Takematsu of Kyushu University, Japan has been essential to take CREAMS from dreams to reality, across national boundaries. The success of CREAMS activities would have never been possible without unselfish support from the staff of the CREAMS Office at the Research Institute for Applied Mechanics, Kyushu University headed by Prof. Jong-Hwan Yoon. Also the professional skill and cooperation by officers and crew of Russian *R/V PROFESSOR KHROMOV AND R/V PAVEL GORDIENKO* at sea have been vital to make CREAMS successful. For all participants CREAMS has been a very challenging, but extremely rewarding experience. Personally I thank all CREAMS scientists, particularly Prof. Kyung-Ryul Kim, for sharing their vision and excitement with me. I appreciate deeply comments by Prof. Steve Riser and Dr. Howard Freeland on this note.

REFERENCES

Gamo, T. and Y. Horibe, 1983. Abyssal circulation in the Japan Sea. J. Oceanogr. Soc. Japan. 39:220-230.

Gamo, T., Y. Nozaki, H. Sakai, T. Nakai and H.Tsubota, 1986. Spatial and temporal variations of water mass characteristics in the Japan Sea bottom layer. J. Mar. Res. 44:781-793.

Kawabe, M., 1982a. Branching of the Tsushima Current in the Japan Sea, Part I. data analysis. J. Oceanogr. Soc. Japan. 38:97-107.

Kawabe, M., 1982b. Branching of the Tsushima Current in the Japan Sea, Part II. numerical experiment. J. Oceanogr. Soc. Japan. 38:183-192.

Kim, C.-H. and J.-H. Yoon, 1994. Circulation of the Japan Sea as seen in the prognostic numerical model. Kaiyo Monthly, 26:762-766.

Kim, K., and J. Y. Chung. 1984. On the salinity-minimum and dissolved oxygen-maximum layer in

the East Sea (Sea of Japan). In: Ocean Hydrodynamics of the Japan and East China Seas. T. Ichiye. editor. Elsevier Science Publishers. Amsterdam. 55-65.

Kim, K., and R. Legeckis, 1986. Branching of the Tsushima Current in 1981-83. Progress in Oceanography, 17:256-276.

Kim, K., K.R. Kim, Y.-K. Cho, A. Scherbinin, S. Yarosh and Y.-G. Kim, 1996. Preliminary report on the CTD and chemical observations during CREAMS'95 Summer Expedition. Proceedings of 4th CREAMS Workshop, Vladivostok, February 12-13, 1996, 45-50.

Lim, D.B. and S. Chang, 1969. On the cold water mass in the Korea Strait. J. Oceonol. Soc. Korea, 4:71-82.

Moriyasu, S., 1972. The Tsushima Current. In: Kuroshio, H. Stommel and K. Yoshida, editors, University of Washington Press, 353-369.

Takematsu, M., A.G. Ostrovskii and T. Kitamura, 1994. Current features in the Japan Sea Proper Water. Program and Report, 3rd CREAMS Workshop, Seoul, November 7-8, 1994, 1-4.

Uda, M., 1934. The results of simultaneous oceanographical investigations in the Japan Sea and its adjacent waters in May and June, 1932 (in Japanese). J. Imperial Fishery Experimental Station, 5:57-190.

Winterfeld, T. and H. Stommel, 1972. Distribution of stations, and properties at standard depths in the Kuroshio area. In: Kuroshio, H. Stommel and K. Yoshida, editors, University of Washington Press, 81-93.

Yasui, M., T. Yasuoka, K. Tanioka and O. Shiota, 1967. Oceanographic studies of the Japan Sea (1) - Water characteristics -. The Oceanogr. Soc. Japan, 19:177-192.

Yoon, J. H., 1982a. Numerical experiment on the circulation in the Japan Sea, Part I: Formation of the East Korean Warm Current. J. Oceanogr. Soc. Japan, 38:43-51.

Yoon, J. H., 1982b. Numerical experiment on the circulation in the Japan Sea, Part II: Influence of seasonal variations in atmospheric conditions on the Tsushima Current. J. Oceanogr. Soc. Japan, 38:81-94.

Yoon, J. H., 1982c. Numerical experiment on the circulation in the Japan Sea, Part III: Formation of the nearshore branch of the Tsushima Current. J. Oceanogr. Soc. Japan, 38:119-124.

TCODE Inventory of Long-term Time Series

Robin Brown
Ocean Physics, Inst. of Ocean Sciences
P.O. Box 6000, Sidney
B.C., CANADA V8L 4B2
E-mail:rmbrown @ios.bc.ca

The Technical Committee on Data Exchange (TCODE) has assembled a list of important datasets of long-term trends in the physical, chemical and biological environment of the North Pacific. These datasets are particularly important for the retrospective analyses that are to be carried out in the PICES Climate Change and Carrying Capacity (CCCC) studies.

The primary objective was to provide short descriptions and "pointers" to the locations of the datasets, to assist researchers in selecting and accessing a diverse set of long-term data. The criteria for inclusion were loose - we were interested in any data that was considered to be relevant to the PICES area that spanned (or will eventually span) a period of 10 years or more. We have included references to some global datasets, as well as references to some observations in equatorial waters which are known to have had impacts on the North Pacific.

For convenience, we have classified the datasets into four categories:

- Biological Oceanographic Data
- Fisheries Data
- Meteorological Data
- Physical and Chemical Oceanographic Data

It is important to note that some datasets are difficult to fit in this scheme (for example, marine mammal abundance data are included in the "Fisheries Data" category) and some datasets span more that one category (e.g. the Comprehensive Ocean-Atmospheric dataset, COADS, contains sea surface temperature data , which fit in the Physical and Chemical Oceanographic Data category and atmospheric pressure data, which is Meteorological Data). We have placed each dataset in the most appropriate category, so users may want to scan associated categories when searching for data. The inventory is organized as *SUMMARY* pages (one for each of the above categories) with a *DETAIL* page for each dataset. Where possible, we have included Internet URL (universal resource Locators) for institutions that provide on-line access to these data.

To access the inventory on the WWW, follow the *Data Inventory Information* link from the PICES Home Page (http://pices.ios.bc.ca) and select the *Inventory of Long Time Series*. In addition to following the *subject area/ summary information/ detailed information* structure of the *Inventory*, users may search the entire PICES WWW site (including the *Inventory*) for articles containing specified key words using the "Search this Site" function on the PICES Home Page. If you do not have access and require a printed copy of the *Inventory*, please contact the PICES Secretariat. This is "work in progress" and you can expect updates and additions to the *Inventory* periodically. We also anticipate adding new subject areas (Marine Mammals and Seabirds, Contaminants) within the next year.

If you have any questions about the *Inventory*, please contact the TCODE Chairman (Robin Brown; rmbrown@ios.bc.ca), the PICES Assistant Executive Secretary (Dr. Alexander Bychkov, bychkov@ios.bc.ca) or one of your national representatives on TCODE. **PLEASE feel free to contribute notes on additional data series that you believe may be useful !**

Chairman for the PICES Fishery Committee

The Chairman of Fishery Science Committee Dr. Qi-Sheng Tang's (China) term has come to an end and Dr. Chang-Ik Zhang of the Republic of Korea was elected for a three-year term. Dr. Zhang received his B.Sc. (1976) and M.Sc. (1981) in fisheries biology from the Jeju National University and the National Fisheries University at Pusan respectively. He got his Ph.D. in fisheries ecology from the University of Washington in 1987. Currently Dr. Zhang is Professor at the Department of Marine Production Management of the Pukyung National University, Pusan, Korea. His fields of interest are fisheries ecology, fish population dynamics and stock assessment, and fishery management. Dr. Zhang is the author of two books (1991 & 1994) in fisheries ecology and the winner of the Most Significant Paper Award from the American Fisheries Society in 1991 and the Best Paper Awards from the Korean Corporation of Science and Technology in 1993 and from the Korean Fisheries Society in 1994. In 1995-1996 he was a member of the PICES Fishery Science Committee.

PICES Sixth Annual Meeting

OCTOBER 14-26, 1997

Pusan, Korea

- Bass Symposium (SB): Ecosystem dynamics in the eastern and western gyres of the subarctic Pacific
- Circulation and ventilation of North Pacific marginal and semi-enclosed seas (POC)
- Micronekton and their predators: Distributions, dynamics and sampling problems (BIO & FIS)
- Models for linking climate and fish (FIS & BIO)
- Environmental impact of aqauculture (MEQ)
- Harmful algal blooms (BIO & MEQ)

Information available at the PICES Secretariat

PICES Publications

This is to inform you that now you can order any of the PICES publications (free of charge, as long as stocks last) through the WWW. To access the publication list and the ordering form, follow the *PICES Publications* link from the PICES Home Page (http://pices.ios.bc.ca)

New Area Code for British Columbia

This is to remind you that the area code for British Columbia (except Vancouver and the Lower Mainland) has been changed from 604 to 250 as of Oct.19, 1996. Please modify phone and fax numbers of PICES Secretariat accordingly on your records, phone and fax speed dials.

PICES PRESS

Published and produced by PICES Secretariat

c/o Institute of Ocean Sciences, P.O.Box 6000
Sidney, B.C., Canada V8L 4B2
Tel.: (1-250) 363-6366
Fax: (1-250) 363-6827
E-mail: pices@ios.bc.ca

ISSN 1195-2512